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(RESEARCH ARTICLE)

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Assessing the Impact of Public Health Interventions on Measles Prevention and Control in Juba County, South Sudan

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Abstract

Measles remains a significant public health challenge in Juba County, South Sudan, despite global vaccination efforts. Frequent outbreaks highlight ongoing gaps in immunization, public awareness, and access to healthcare services. This study evaluates the impact of public health interventions—including vaccination campaigns, risk communication, community engagement (RCCE), and case management—on measles prevention and control. A cross-sectional study was conducted among 243 households with children under 18 years. Findings revealed that 86.25% of children received at least one dose of the measles vaccine, but only 16.25% completed the full two-dose schedule. Alarmingly, 13.75% remained unvaccinated due to misinformation (40.83%), cultural and religious beliefs (18.18%), and lack of access to healthcare facilities (12.92%). Encouragingly, 82.5% of respondents participated in public health education initiatives, with community health volunteers playing a key role (63.33%). While vaccination campaigns and RCCE strategies have improved immunization rates and awareness, challenges persist. Misinformation, logistical barriers, and cultural resistance continue to hinder full immunization coverage. Strengthening healthcare infrastructure, increasing vaccine accessibility, and expanding grassroots health education programs are essential steps toward sustainable measles control. Additionally, collaboration between public health officials, community leaders, and healthcare workers is crucial for overcoming vaccine hesitancy and ensuring widespread immunization. By addressing these persistent challenges, Juba County can move closer to preventing future outbreaks and securing better health outcomes for children.

Keywords: Measles; Vaccination; Public health interventions; Risk communication; Community engagement; Juba County; South Sudan

1. Introduction

1.1. Background of the study

Measles is a highly contagious viral disease that primarily affects children. It is characterized by fever, cough, runny nose, conjunctivitis, and a distinctive rash [1]. Despite global efforts to control measles through vaccination, outbreaks persist, particularly in low-resource settings [2]. The disease spreads through respiratory droplets, and the virus can remain airborne for up to two hours after an infected person leaves the area [3].

Global measles cases increased by 18% in 2021-2022, with deaths rising by 43% [4]. The World Health Organization (WHO) estimates that at least 95% coverage of both vaccine doses is required for herd immunity [5]. However, global vaccination coverage lags, with only 83% of children receiving the first dose in 2022 [6].

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Sub-Saharan Africa, including South Sudan, has seen a significant measles resurgence, with a 400% increase in cases in 2022 compared to 2021 [7]. The situation in Juba County exemplifies these challenges, as ongoing humanitarian crises and weak healthcare infrastructure contribute to repeated measles outbreaks [8].

1.2. Problem Statement

Despite vaccination efforts, measles outbreaks in Juba County persist, straining healthcare resources and putting children at high risk of severe complications such as pneumonia, encephalitis, and malnutrition [9]. Understanding the effectiveness of public health interventions in this setting is crucial for developing targeted strategies to reduce measles incidence [10].

1.3. Rationale of the study

Measles is a highly contagious viral disease that remains a significant public health concern, particularly in low-resource settings like Juba County, South Sudan [8]. Despite the availability of an effective vaccine, measles outbreaks continue to occur, indicating persistent challenges in achieving and maintaining high vaccination coverage. Several factors contribute to these challenges, including limited healthcare infrastructure, socio-economic barriers, cultural beliefs, and inadequate public health education [8] Juba County has experienced recurrent measles outbreaks, which strain the local healthcare system and pose severe risks to the health of its population, especially among children [7]. These outbreaks highlight potential gaps in current public health interventions and the need for a thorough evaluation to understand their effectiveness [7]. Assessing the impact of these interventions is crucial for identifying successful strategies and areas needing improvement, ultimately aiming to enhance measles prevention and control efforts.

1.4. Significance of the study

- Policy and Program Enhancement: Provides evidence-based insights for policymakers to refine and develop more effective measles prevention and control strategies.
- Efficient Resource Allocation: Helps ensure that limited healthcare resources are directed towards the most effective interventions.
- Barrier Identification and Mitigation: Identifies socio-economic, cultural, and logistical barriers to measles prevention, offering actionable recommendations to overcome these challenges.
- Community Health Benefits: Improved measles control will lead to better health and well-being for the community, reducing healthcare costs and improving quality of life.
- Contribution to Global Health Goals: Supports regional and international efforts towards measles elimination, providing lessons applicable to similar settings.
- Capacity Building: Enhances local capacity for health research and intervention evaluation, empowering local health professionals and stakeholders.

1.5. Objectives of the study

1.5.1. General objective

To assess the Impact of Public Health Interventions on Measles Prevention and Control in Juba County, South Sudan.

Specific objective

- To evaluate the effectiveness of specific public health interventions, including vaccination campaigns, risk communication and community engagement (RCCE), and case management, in reducing measles outbreaks in Juba County.
- To describe the factors that could lead to vaccine failure in Juba County.
- To investigate the current strategies employed in measles prevention and control, focusing on vaccination campaigns, RCCE, and case management

2. Material and methods

2.1. Study Design

The study employed quantitative, cross-sectional study design to provide a comprehensive assessment of the impact of public health interventions on measles prevention and control in Juba County, South Sudan.

2.2. Study Population

Households in Juba County with children less than 18 years.

2.3. Study area

The study was conducted in Juba County within the larger Central Equatoria State and is the capital of South Sudan. Juba County includes both urban and rural areas, with varying population densities and healthcare infrastructure. The study may focus on specific areas within Juba County, such as urban centers like Juba city and surrounding rural communities.

2.4. Sampling Technique

Stratified random sampling technique was used for the study.

2.5. Sample Size Determination

Baseline measles incidence rate P in Juba County, South Sudan 19.7% (Obwoya, 2020), Confidence level: 95% (Z-score of 1.96 for a two-tailed test), Margin of error E: 5% (corresponding to a confidence interval of 95%).

Formula for estimating sample size for proportions: $N = Z^2 \times P \times ((1-P)/E^2)$

$$N = (1.96)^2 \times 0.197 \times ((1-0.197) / (0.05^2)$$

$$3.8416 \text{ x } 0.197 \text{ x } (0.803/0.0025) = 243.08$$

The estimated sample size required for this study was approximately 243 individuals.

2.6. Data Collection

Structured questionnaires was used for the study

2.7. Data Analysis

Descriptive statistics to summarize vaccination coverage and incidence rates; inferential statistics (e.g., chi-square tests, logistic regression) to assess associations between variables.

3. Results and discussion

3.1. Demographics of the research participants

Understanding the demographics of the research participants is essential for assessing the impact of public health interventions on measles prevention and control in Juba County, South Sudan. The demographics provide insights into the population's characteristics, which can influence the effectiveness and reception of health interventions.

3.1.1. Age Distribution of research participants

Table 1 Age of the participants

Category	No.	%
Under 18	14	5.83
18-24	45	18.75
25-34	47	19.58
35-44	54	22.50
45-54	41	17.08
55-64	24	10.00
65 and above	15	6.25
Total	240	100.00

Under 18 (5.83%): This age group comprises children and adolescents who are directly affected by measles and are typically the primary targets for vaccination campaigns. However, their relatively low representation in the sample may indicate challenges in reaching this age group or reliance on caregivers for participation. 18-24 (18.75%): Young adults in this age range are often in transitional life stages, such as completing education or starting work. They may have varied levels of health awareness and access to healthcare services. 25-34 (19.58%): This demographic is often considered to be in their prime reproductive and parenting years, making them critical for promoting vaccination among their children. Their relatively high representation suggests their active involvement in health-related decisions. 35-44 (22.50%): The largest group, individuals in this age range are likely to be established in their careers and family lives, holding significant influence over health practices within households and communities. 45-54 (17.08%): This group includes middle-aged adults who might have grown-up children and could play a role in intergenerational health education and advocacy. 55-64 (10.00%): Older adults in this range may face different health priorities but still play an essential role in community health dynamics and vaccination advocacy. 65 and above (6.25%): The elderly are often respected figures in communities and can significantly influence public health practices and beliefs. However, their lower representation may reflect challenges in engagement or mobility.

3.1.2. Gender of research participants

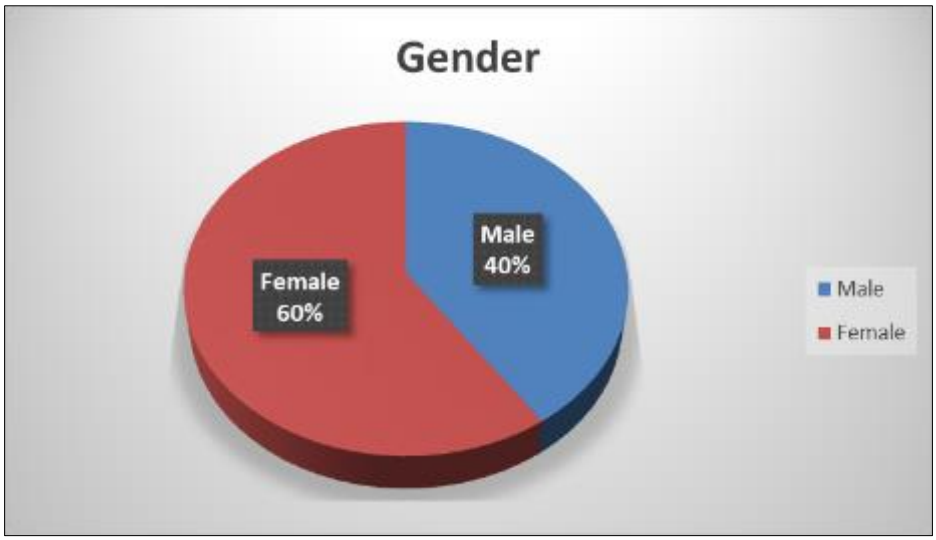

Figure 1 Gender distribution of the participants

Male (40.42%): Men's participation is crucial for comprehensive public health strategies. Their relatively lower representation compared to females suggests potential barriers in reaching men or differences in health-seeking behaviors. **Female (59.58%)**: Women, often primary caregivers, play a pivotal role in family health decisions. Their higher participation indicates their active role in health interventions and underscores the importance of targeting women in health campaigns.

3.1.3. Education Level of the Research Participants

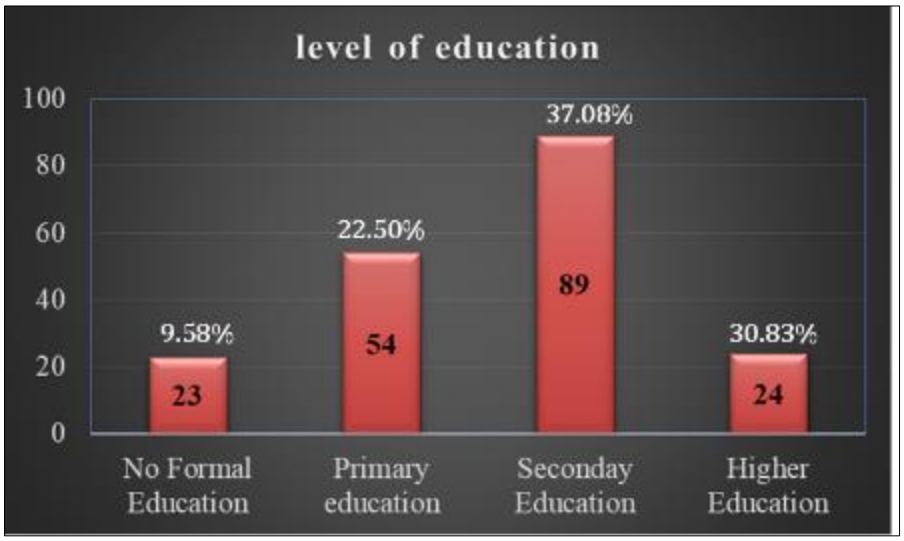

Figure 2 Educational level of the participants

No Formal Education (9.58%): This group may have limited health literacy, making tailored educational interventions necessary to ensure they understand and trust vaccination programs. Primary Education (22.50%): Participants with primary education can grasp basic health concepts but may still require clear and straightforward communication. Secondary Education (37.08%): With secondary education, individuals are likely to have better health literacy and be more receptive to public health messages. Higher Education (30.83%): Those with higher education can critically evaluate health information and advocate for health practices within their communities. Their significant representation suggests a favorable environment for implementing health interventions that require community mobilization and leadership.

3.1.4. Occupation of the Research Participants

Table 2 Occupation of the participants

Occupation	**No.**	**%**
Healthcare worker	20	8.33
Teacher	33	13.75
Businessperson	47	19.58
Student	42	17.50
Unemployed	98	40.83
Total	240	100.00

Healthcare Workers (8.33%): As frontline responders, healthcare workers' involvement in the study is crucial. They can provide insights into the healthcare system's strengths and weaknesses regarding vaccination campaigns. **Teachers (13.75%)**: Educators can influence young minds and spread awareness about health practices among students and their families. **Businesspersons (19.58%)**: Engaging this group is vital as they often have extensive networks and can contribute to broader community outreach. **Students (17.50%)**: Young and educated, students can be effective advocates for health interventions among their peers and families. **Unemployed (40.83%)**: This significant group may face economic barriers to accessing healthcare. Their high representation underscores the need for accessible and affordable health services and education.

3.1.5. House hold size of the research participants

Table 3 Household size of the participants

Size	No.	%
1-3	98	40.83
4-6	72	30.00
7-9	42	17.50
10 or more	28	11.67
Total	240	100

1-3 Members (40.83%): Smaller households may have better resource allocation per member, potentially leading to better health outcomes. 4-6 Members (30.00%): Moderate-sized households are common and represent typical family units in many communities. Health interventions must account for dynamics within such households. 07-9 Members (17.50%): Larger households might face challenges in ensuring all members are vaccinated and educated about health practices due to resource constraints. 10 or More Members (11.67%): Very large households may struggle significantly with resource distribution, making targeted interventions critical for ensuring no one is left behind.

The demographic analysis provides a roadmap for designing and implementing effective public health interventions to control and prevent measles in Juba County.

3.2. Vaccination and Vaccination Coverage

Understanding the vaccination status and coverage among the research participants in Juba County is essential for assessing the effectiveness of public health interventions aimed at measles prevention and control. The data collected on vaccination coverage, reasons for non-vaccination, location of vaccination, doses received, and public health education programs provide valuable insights into the current state of measles control efforts and areas that need improvement.

3.2.1. Vaccination coverage

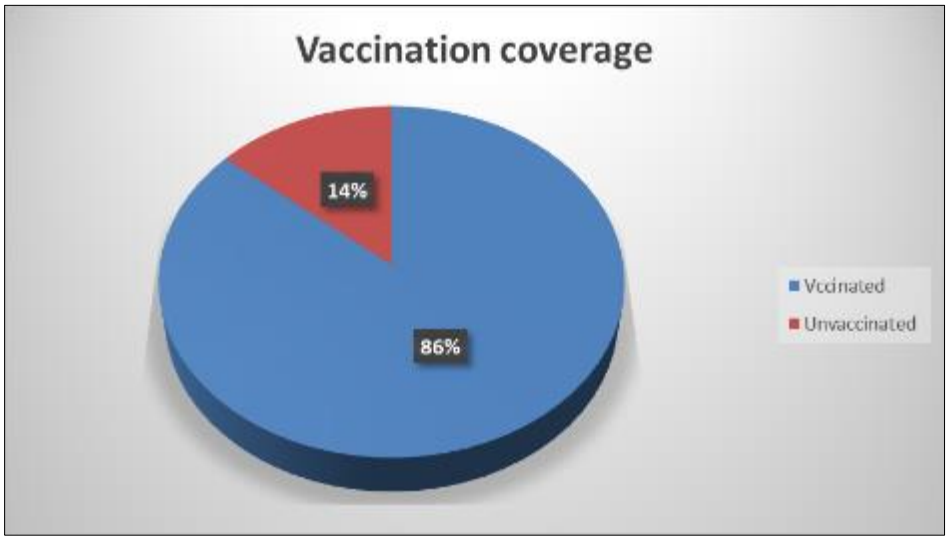

Figure 3 Vaccination Coverage

Vaccinated **(86.25%)**: A high percentage of participants reported being vaccinated. This indicates a successful reach of vaccination campaigns to a significant portion of the population. High vaccination coverage is crucial in achieving herd immunity, which protects the community, including those who are not vaccinated. Unvaccinated **(13.75%)**: Although the unvaccinated percentage is relatively small, it still represents a substantial number of individuals who are at risk of

contracting and spreading measles. This group poses a threat to the overall goal of measles elimination and highlights the need for targeted interventions to reach these individuals.

3.2.2. Reason for not vaccinating their children

Table 4 Reason for not vaccinating children

Reason	No.	%
Fear for side	3	9.09
I don't know	1	3.03
Lack of awareness	17	51.52
Not reach to our homes	1	3.03
Religion/ cultural belief	6	18.18
Vaccine not available	5	15.15
Total	33	100.00

Lack of Awareness (51.52%): The most common reason for non-vaccination is a lack of awareness about the vaccine. This suggests a significant gap in public health education and communication efforts. Increasing awareness through targeted educational campaigns can help mitigate this issue. Cultural/Religious Beliefs (18.18%): Cultural and religious beliefs play a significant role in health behaviors. Addressing these beliefs through culturally sensitive communication and involving community and religious leaders in advocacy efforts can help overcome this barrier. Fear of Side Effects (9.09%): Fear of potential side effects of the vaccine is another barrier. Providing clear and accurate information about the safety and benefits of the vaccine, along with addressing specific concerns, can help alleviate these fears. Vaccine Availability (15.15%): Issues related to vaccine availability, such as stockouts or logistical challenges, need to be addressed to ensure a consistent supply of vaccines. Access Issues (3.03%): Inaccessible vaccination services indicate a need for more widespread and convenient vaccination sites. Lack of Knowledge about the Vaccine (3.03%): General lack of knowledge underscores the importance of ongoing education and communication efforts.

3.2.3. Location of vaccination

Table 5 Vaccination location

Location	No.	%
Public health facility	107	44.58
Mobile vaccination unit	69	28.75
Private clinic	20	8.33
School	23	9.58
Community outreach	21	8.75
Total	240	100.00

Public Health Facility (44.58%): The majority of vaccinations occur in public health facilities, highlighting the importance of strengthening these facilities to maintain and increase vaccination rates. Mobile Vaccination Units (28.75%): Mobile units play a crucial role in reaching remote and underserved populations. Expanding mobile vaccination services can further improve coverage. Private Clinics (8.33%): Private clinics contribute to vaccination efforts but on a smaller scale. Partnerships with private healthcare providers can help increase overall coverage. Schools (9.58%): Schools are effective venues for vaccination campaigns, particularly for reaching children and adolescents. Community Outreach (8.75%): Community outreach programs are essential for engaging hard-to-reach populations. Expanding these efforts can improve accessibility and coverage.

3.2.4. Dose(s) of vaccination received by their children

Table 6 Vaccination dose(s) received

Dose(s)	No.	%
One	176	73.33
Two	39	16.25
Three	6	2.50
Do not know	19	7.92
Total	240	100.00

One Dose (73.33%): While one dose provides some level of immunity, it is often not sufficient for long-term protection. Efforts should be made to ensure that individuals receive the recommended two doses. Two Doses (16.25%): This group is adequately protected, demonstrating the success of complete vaccination efforts. Three Doses (2.50%): A small percentage received an extra dose, which may indicate catch-up vaccinations or error in recording. Do Not Know (7.92%): Uncertainty about vaccination status suggests a need for better record-keeping and communication with vaccine recipients.

3.3. Public Health Education Program

Public health education is a critical component in the prevention and control of measles in Juba County. It helps to increase awareness, dispel myths, and promote vaccination among the population. The data on public health education participation and delivery methods provides insight into the effectiveness and reach of these programs.

3.3.1. Public Health Program Attenders

Table 7 Public health program attenders

Attenders	No.	%
Yes	198	82.50
No	42	17.50
Total	240	100.00

Attenders (82.50%): High participation in public health education programs indicates good community engagement. These programs are vital for increasing awareness and addressing misconceptions about vaccines. Non-Attenders (17.50%): Efforts should be made to reach the minority who did not participate in education programs, as they may represent a vulnerable group less informed about the benefits of vaccination.

3.3.2. Public health education program provider

Table 8 Public health education program providers

Provider	No.	%
Community health volunteers	152	63.33
Health care workers	58	24.17
Teachers	17	7.08
Religious leaders	13	5.42
Total	240	100.00

Community Health Volunteers (63.33%): Community health volunteers are the primary providers of public health education, indicating their crucial role in disseminating information and promoting health behaviors. Healthcare

Workers (24.17%): Healthcare workers also play a significant role in education, leveraging their expertise and trust within the community. Teachers (7.08%): Involving teachers in health education can be effective, particularly in school-based programs. Religious Leaders (5.42%): Religious leaders have the potential to influence their congregations positively. Engaging them in health education can help address cultural and religious barriers.

3.3.3. Method used for public health education

Table 9 Methods of public health education

Methods	**No.**	**%**
Workshop	42	17.50
Community meetings	88	36.67
Media campaign	56	23.33
School programs	39	16.25
Others	15	6.25
Total	240	100.00

Community Meetings (36.67%): Community meetings are the most common method used, indicating their effectiveness in engaging the community and facilitating discussions. Media Campaigns (23.33%): Media campaigns are essential for reaching a wide audience quickly and can be particularly effective in spreading awareness about vaccination. Workshops (17.50%): Workshops provide in-depth information and interactive learning opportunities. School Programs (16.25%): School programs target young populations and can influence both students and their families. Other Methods (6.25%): Other methods, although less common, still contribute to the overall effort and should not be overlooked.

3.3.4. Barriers / Challenges hinder the complete control of measles

Despite the efforts in public health education and vaccination campaigns, several barriers and challenges hinder the complete control of measles in Juba County. Identifying and addressing these barriers is crucial for improving vaccination rates and public health outcomes.

Table 10 Barriers to complete control of measles

Barriers	**No.**	**%**
Misinformation	98	40.83
Culture/religious belief	22	9.17
Lack of access to health facility	31	12.92
Insufficient vaccination supply	19	7.92
Lack of awareness	51	21.25
Fear of side effect	19	7.92
Total	240	100.00

Misinformation (40.83%): Misinformation is the most significant barrier, affecting nearly half of the population. This includes false beliefs about vaccine safety, effectiveness, and the nature of the disease itself. To combat misinformation, Strengthen communication Use credible sources and trusted community figures to disseminate accurate information. Fact-checking initiatives, Implement community-based fact-checking and myth-busting campaigns to correct false information. Cultural/Religious Beliefs (9.17%): Cultural and religious beliefs can influence health behaviors and attitudes towards vaccination. To address these: Engage religious and community leaders, Involve them in public health education to align health messages with cultural and religious values. Develop educational materials that respect and incorporate cultural beliefs while promoting health practices. Lack of Access to Health Facilities (12.92%): Access issues can prevent individuals from receiving vaccinations. Solutions include Mobile clinics and Community health centers.

Insufficient Vaccination Supply (7.92%), Supply chain issues can lead to vaccine shortages, hindering vaccination efforts. To ensure consistent supply, Improve logistics to Enhance vaccine storage, distribution, and inventory management systems. Collaborate with international organizations to ensure a steady supply of vaccines. Lack of Awareness (21.25%): Lack of awareness about the importance of vaccination and measles prevention is a significant barrier. Strategies to increase awareness include, Comprehensive education campaigns and Targeted outreach. Fear of Side Effects (7.92%): Fear of vaccine side effects can deter individuals from getting vaccinated. Addressing this fear involves transparent communication, Support and reassurance.

4. Conclusion

This study highlights the significant impact of public health interventions on measles prevention in Juba County, South Sudan. Findings reveal that vaccination campaigns, risk communication, and community engagement efforts have improved immunization coverage and awareness. However, misinformation, cultural resistance, and healthcare accessibility remain critical challenges. Addressing these barriers through strengthened healthcare infrastructure, targeted public health education, and improved vaccine accessibility is essential for sustainable measles control.

This study provides valuable insights for policymakers and healthcare practitioners, guiding the development of more effective measles prevention strategies. Strengthening collaboration between health authorities and local communities will enhance disease surveillance and outbreak response. By implementing these measures, Juba County can move closer to eliminating measles and ensuring better health outcomes for its population.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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